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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/829,136	04/21/2004	Hee-hwan Choe	8116-1 (PL0026/US)	5461

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F. CHAU & ASSOCIATES, LLP
Suite 501
1900 Hempstead Turnpike
East Meadow, NY 11554

EXAMINER

DHINGRA, RAKESH KUMAR

ART UNIT	PAPER NUMBER
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1763

DATE MAILED: 05/04/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/829,136

Applicant(s)

CHOE ET AL.

Examiner

Rakesh K. Dhingra

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 21 April 2004.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-6 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-6 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Claim Rejections - 35 USC § 102

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

Claims 1-6 are rejected under 35 U.S.C. 102 (b) as anticipated by Donohoe et al (US Patent No. 6,309,978 B1).

Regarding Claim 1: Donohoe et al teach a plasma generation apparatus (Figure 4) comprising a process chamber 101 with a pair of RF electrodes 102, 103, showing the lower electrode 102 connected to a multi-frequency RF source 114 (column 5, line 20-38) and using beat frequency modulation method for plasma generation; the multi-frequency source 114 (per Figure 6) includes three frequency generators 31, 32, 33 which may provide discrete frequency and discrete power levels (Column 6, lines 14-17) as shown in Figure 7. Donohoe also teaches that modulated-bias plasma means that plasma is generated by bias power or driving power modulated by at least one beat frequency (Column 3, lines 13-17) and bias power is pulsed with low frequency beating signal to produce the plasma. Donohoe also teaches that filters may be employed for blocking out unwanted frequencies (Col 6, lines 40-43); the multi-frequency RF source 114 (per Figure 6) includes a mixer 37 which combines the output signals of three frequency generators 31, 32, 33 and provides output signal 30 (having a beat component) to the lower electrode 102 (column 6, lines 5-13).

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Regarding Claim 2: Donohoe teaches that modulated-bias plasma generation (Figure 4) is facilitated by the multi-frequency RF source 114 (Column 5, lines 25-30) which includes (per Figure 6) three frequency generators whose frequencies interfere with each other to produce beat which produces a modulated-bias plasma; the multi-frequency RF source (per Figure 6) includes a mixer 37 which combines the output of three frequency generators 31, 32, 33 and supplies the output signal 30 to the lower electrode 102 (Figure 4).

Regarding Claim 3: Donohoe et al teach that for mixer 37 (Figure 6) summing junction (adding) is preferred for the high frequencies used for plasma generation (Column 6, lines 30-35).

Regarding Claim 4: as explained above, for mixer 37 (Figure 6) summing junction (adding) is preferred for the high frequencies used for plasma generation (Column 6, lines 30-35).

Regarding Claim 5: Donohoe et al also teach (Figure 7) that the three frequencies can be different (per Figure 7)

Regarding Claim 6: as explained above, the three frequencies can be different (per Figure 7).

Claims 1, 3, 5 are rejected under 35 U.S.C. 102 (e) as anticipated by Quon et al (Pub. No. US2003/0094239 A1).

Regarding Claim 1: Quon et al teach a plasma generation apparatus 20 (Figure 3A) comprising a process chamber with a wafer supporting chuck 18;

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a very high frequency generator 14 (page 3, paragraphs 0022, 0023) and a VHF match network 30;

a low frequency RF generator 16 (for bias) and a low frequency RF match network 32;

a mixer (combiner) circuit 34 which adds (superposes) the respective RF and VHF

signals (page 3, paragraphs 0024) and a coupling circuit 12 which combines the VHF

and the RF signals at the chuck, while maintaining impedance match between VHF and RF generators and the load (page 3, paragraph 0023) .

Regarding Claim 3: Quon et al teach that the Mixer 34 adds the respective RF and VHF signals and the coupler circuit 12 is electrically connected to chuck via a transmission line 21 (page 3, paragraph 0024).

Regarding Claim 5: Quon et al teach that the RF bias frequency is lower than the VHF frequency (page 3, paragraph 0022).

Claims 1, 3, 5 are rejected under 35 U.S.C. 102 (e) as anticipated by Suemasa et al (US Patent N0. 6642149).

Regarding Claim 1: Suemasa et al teach a plasma processing apparatus (Figure 1) comprising:

a processing chamber 102 with a lower electrode 106 and an upper electrode 108 (page 2, paragraph 0019);

a first high frequency power supply 114 comprising a first power source 122 and a first matching device 120 (page 2, paragraph 0020);

a second high frequency power supply (bias) 116 composed of a second power source 128 and a first matching device 126 (page 2, paragraph 0020), and by varying powers

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of the two different high frequency components the density of plasma and self-bias voltage are controlled (page 1, paragraph 0006);

wherein the output of the first and second high frequency power supplies 114 and 116 are superimposed and coupled to the lower electrode 106 (page 2, paragraph 0020).

Regarding Claim 3: Suemasa et al teach a main power supply device 112 which combines the output of the first and second high frequency power supplies 114 and 116 and which is connected to the lower electrode 106 for supplying a superimposed power of the two frequencies coming from the first and second high frequency power supplies (page 2, paragraph 0020).

Regarding Claim 5: Suemasa et al teach about a second high frequency supply 116 for producing a high frequency power component, which is lower than the first high frequency power component supplied by the first high frequency power supply 114 (page 2, paragraph 0020).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation

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under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 2, 4, 6 are rejected under 35 U.S.C. (a) as being unpatentable over Quon et al (Pub No. US 2003/0094239 A1) in view of Donohoe et al (US Patent No. 6309978 B1).

Quon et al teach all limitations of claim 1, as discussed above, except for the auxiliary power supply.

Regarding Claim 2: Donohoe et al teach a plasma generation apparatus (Figure 4) comprising a process chamber 101 with a pair of RF electrodes 102, 103, showing the lower electrode 102 connected to a multi-frequency RF source 114 (column 5, lines 20-38);

Per Figure 6, the multi-frequency RF source includes a mixer 37, which combines the output of three frequency generators 31, 32, 33 to provide the output signal 30 having a beat component, which is coupled to the lower electrode 102 (column 6, lines 6-14).

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to utilize three frequencies to produce beat and produce a modulated-bias plasma, as taught by Donohoe et al in the apparatus of Quon et al, to enable a more efficient process due to higher ion energy for etching and improvement in power consumption.

Regarding Claim 4: Donohoe et al teach that for mixer 37 (Figure 6) summing junction (adding) is preferred for the high frequencies used for plasma generation (column 6, lines 30-35).

Regarding Claim 6: As explained above, Donohoe et al also teach (per Figure 7) that the three frequencies can be different.

Claims 2, 4, 6 are rejected under 35 U.S.C. (a) as being unpatentable over Suemasa et al (Patent No. 6642149) in view of Donohoe et al (US Patent No. 6309978 B1).

Suemasa et al teach all limitations of claim 1, as discussed above, except for the auxiliary power supply.

Regarding Claim 2: Donohoe et al teach a plasma generation apparatus (Figure 4) comprising a process chamber 101 with a pair of RF electrodes 102, 103, showing the lower electrode 102 connected to a multi-frequency RF source 114 (column 5, lines 20-38);

Per Figure 6, the multi-frequency RF source includes a mixer 37, which combines the output of three frequency generators 31, 32, 33 to provide the output signal 30 having a beat component, which is coupled to the lower electrode 102 (column 6, lines 6-14).

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to utilize three frequencies to produce beat and produce a modulated-bias plasma, as taught by Donohoe et al in the apparatus of Suemasa et al, to enable a more efficient process due to higher ion energy for etching and improvement in power consumption.

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Regarding Claim 4: Donohoe et al teach that for mixer 37 (Figure 6) summing junction (adding) is preferred for the high frequencies used for plasma generation (column 6, lines 30-35).

Regarding Claim 6: As explained above, Donohoe et al also teach (per Figure 7) that the three frequencies can be different.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Craig (US Patent No. 6,043,607) teaches a plasma apparatus (Figure 1) wherein a complex waveform is generated by multiple signal generators and coupled to a high power amplifier, which is then supplied to plasma excitation circuit through selective matching networks.

Barnes et al (US Pub. No. 2003/0037881) teach plasma apparatus (Figure 3) wherein a low frequency and a high frequency power sources are connected to lower electrode through respective matching circuits, and a variable impedance element which can be tuned to control self-bias voltage division between the two electrodes.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Rakesh K. Dhingra whose telephone number is (571)-272-5959. The examiner can normally be reached on 8:30 -6:00 (Monday - Friday).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Parviz Hassanzadeh can be reached on (571)-272-1435. The fax phone

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number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Rakesh K Dhingra


PARVIZ HASSENZADEH
SUPERVISORY PATENT EXAMINER